AFRL-RI-RS-TR-2009-89
Final Technical Report
April 2009

VIRTUAL ENVIRONMENTS OVERVIEW

IBM Almaden Research Center

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FOR THE DIRECTOR:

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PETER J. ROCCI, JR.   JOSEPH CAMERA, Chief
Work Unit Manager   Information & Intelligence Exploitation Division
                                                         Information Directorate

REPORT DOCUMENTATION PAGE

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
APR09	Final	Sep 08 – Dec 08

4. TITLE AND SUBTITLE		5a. CONTRACT NUMBER
VIRTUAL ENVIRONMENTS OVERVIEW		FA8750-08-C-0253
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
		N/A

6. AUTHOR(S)	5d. PROJECT NUMBER
Susan U. Stucky	R665
Ben Shaw	5e. TASK NUMBER
Wendy Ark	08
	5f. WORK UNIT NUMBER
	08

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
IBM Almaden Research Center 650 Harry Road San Jose CA 95120-6001	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
AFRL/RIED 525 Brooks Rd. Rome NY 13441-4505	
	11. SPONSORING/MONITORING AGENCY REPORT NUMBER AFRL-RI-RS-TR-2009-89

12. DISTRIBUTION AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PA# 88-ABW-2009-0917

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This report provides a research-based schema called "A Framework for Designing with Virtual World Technologies". It is shown how, by using this framework, virtual world technologies can be used to radically transform how intelligence analysts encounter data, frame their stories, and review their analyses with both their customers and other analysts. The report explores what analysts can accomplish by doing some of their work in environments that can be created in virtual world platforms. There is no reason why the proposed framework wouldn't be applicable to blended reality solutions in which virtual world applications and real world applications are tightly integrated, or in which elements of virtual world technologies are integrated into more traditional software tools. We are enthusiastic about the possibilities that virtual world technologies make available, yet we do not want to suggest that the current crop (circa 2008-2009) can live up to current hype. Accordingly, we discuss later in the report a number of considerations that need to be taken into account.

15. SUBJECT TERMS
Virtual Environments, Virtual World Technologies, Intelligence Analysis, Decision Making

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Peter J. Rocci, Jr.
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U	UU	49	19b. TELEPHONE NUMBER (Include area code) N/A

ABSTRACT

We provide in this paper a research-based schema called *A Framework for Designing with Virtual World Technologies*. We show how, by using this framework, virtual world technologies can be used to radically transform how intelligence analysts encounter data, frame their stories, and review their analyses with both their customers and other analysts. We explore what analysts can accomplish by doing some of their work in environments that can be created in virtual world platforms.

We focus on the technologies provided by virtual world platforms such as Linden Lab's *Second Life*, Forterra's *Olive*, the enterprise provider *Qwaq*, and The Active Worlds Company's *Active Worlds*. That said, there is no reason why the proposed framework wouldn't be applicable to blended reality solutions in which virtual world applications and real world applications are tightly integrated, or in which elements of virtual world technologies are integrated into more traditional software tools.

We are enthusiastic about the possibilities that virtual world technologies make available, yet we do not want to suggest that the current crop (circa 2008-2009) can live up to current hype. Accordingly, we discuss later in the paper a number of considerations that need to be taken into account. Certainly we (the authors) have seen in our two years of experience in designing virtual world environments that substantial time and effort can be devoted to efforts that do not offer clear advantages over more conventional means. It is this experience that has led us to think about how to design virtual world environments and experiences in a more rigorous and principled manner.

The framework we provide in this paper, while certainly not the only one imaginable, is intended to accomplish three goals.

First, it provides a scheme for how to take advantage of the technologies provided by virtual world platforms to leverage innate human cognitive and perceptual architecture and the genuine social interaction that emerges in these worlds. There is substantial (we would argue, enough) evidence based on existing research to suggest that we may be able to reduce cognitive load and make multi-user computer-mediated interaction more fluid and intuitive. While this is essential to any analyst inundated with data, it is particularly acute for the intelligence analyst, who needs to engage with data in a networked world where face-to face interaction is increasingly unavailable.

Second, it makes virtual world technology design more rigorous and principled. To date, we see that many virtual worlds "builds" aspire to render in great detail, the real world. The question is what kind of veridicality is needed for what purpose. Too, we have found that violating the constraints of the real world may actually produce a cognitively richer experience.

Finally, a framework provides a rationale for evaluation. One can more clearly hypothesize, for instance, what effect any particular instantiation of a virtual world "build" can provide. Taking together the research-based design framework proposed and our experience in designing virtual world environments, we suggest that the current crop of virtual world technologies will best support the collective and interactional aspects of intelligence analysis when face-to-face interaction is intermittent, asynchronous, or impossible for some reason. Unlike teleconferences where difficulty in maintaining shared focus,

orientation, and clarity of reference is the norm, virtual world "builds" can mitigate these constraints. Similarly they shine when activities involve working with inherently spatial relationships that can be rendered in 3D.

Of course, we have all seen these claims for any number of technologies. The attraction here is that many of the affordances of simulation, gaming and virtual reality technologies can be realized through a single platform, and that they are accessible and available to non-professionals in those fields. Much the way offset printing was supplanted by desktop publishing, we see the virtual world technologies as candidates for integrating the technologies of virtual reality, simulation and gaming, crude though they may be at this time.

TABLE OF CONTENTS

1. INTRODUCTION

W. Brian Arthur, in a new book, *The Nature of Technology*, argues that we don't so much "apply" a new technology as "encounter" it. By this he means the technology is not taken as a given and adopted by a community of practitioners for a particular purpose; rather, both the technology and the practice undergo mutual adaptation and co-evolution such that both are changed profoundly by the time a stable plateau—a durable innovation, is reached. His point of view informs how we have approached this white paper. Rather than providing specific direction for application, we offer a model and illustration for interested parties to *encounter* in an informed way, the new, post-2000 crop of 3D Virtual World platforms.

Canonical examples of these relatively recent platforms include Linden Lab's *Second Life*, Forterra's *Olive*, the enterprise provider *Qwaq*, and The Active Worlds Company's *Active Worlds*.

In our analysis, we are not including game development platforms (even though these underlie some of the technologies we discuss). Similarly we are not including video games, virtual reality or sophisticated simulation technologies. All of these are significant in their own right. What we do want to demonstrate is that these virtual world new platforms are accessible and available to non-professionals in those fields much the way offset printing was supplanted by desktop publishing. We see these new virtual world technologies as candidates for integrating the technologies of virtual reality, simulation and gaming, crude though they may be at this time.

While the authors believe that recent developments in 3D Virtual World space may be relevant to many aspects of intelligence analysis, in this paper we took as our context those aspects of the 3D Virtual World space that may be of use in defining programs such as A-SpaceX at IARPA and shaping considerations for BAA's that may be issued. The framework proposed here is targeted at supporting analysts in the work of intelligence analysis and interaction with other analysts and with customers. [1]

To get a look at the wide variety of platforms now existing outside the game space the visual compilation of fifty such platforms by Gary Hayes in 2008 is a representative. As Hayes points out in that video, over 300 million people are registered users of the virtual worlds created in these platforms. And it is increasingly hard to keep up. We see developments at the rate of ten a day; here is an example from a good source, Virtual World News[2] illustrating the rapid and sometimes dramatic changes:

- Ball State University, which has previously brought its libraries into Second Life, has expanded to create a space for architecture students in house and across 30 Latin American colleges collaborate on different designs. More info.
- Glasgow Caledonian University, which previously used Second Life to let prospective students explore the campus, will begin using it to train nurses. More info.
- The United States Holocaust Memorial Museum and Involve are opening an exhibit on Kristallnacht in Second Life next week. More info.
- Ridemakerz is co-developing a new virtual world for its toys with the Electric Sheep Company. More info.

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[1] Importantly, this paper, while written by IBM researchers at IBM's Almaden Research Center, is intended to aid the larger A-Space X community and contains no proprietary IBM information. We draw on documents provided by Dr. Jeffrey G. Morrison regarding proposed programs in the ASpace X program as well as a white paper by Dr. Rita Bush and and Mr. Ken Kiesel.,
[2] http://www.virtualworldsnews.com/ from their "What's new to Virtual Worlds" wrap-up on December 5, 2008

- [Planet Cazmo](#) announced a December Virtual Concert Series with three artists from [Sony Epic Records](#) and [Interscope Geffen A&M Records](#). [More info](#).
- The U.S. Army will open up two islands in Second Life in the next 30-45 days aimed at recruiting new soldiers. [More info](#).
- Singer/producer Kevin Rudolf will be staking out a space in [Entropia Universe](#). [More info](#).
- Red Bull has become the "first" brand in Home for the PlayStation 3. [More info](#).
- The Air Force launched a recruiting center in Second Life. [More info](#).
- The "be Berlin" campaign, local listings guide [Zitty](#), entertainment company [Motor Entertainment GmbH](#) have all taken spots in [Twinity](#). [More info](#).

Popular culture aside, uses of virtual worlds in organizations are exploding both in number and in kind. It used to be possible (around 2006 and early 2007) to track all the public and private organizations that were commissioning virtual world builds. That is no longer the case. Both public and private organizations are experimenting with virtual worlds builds at an increasing pace.[3] (This is progress of a sort; however, new indicators are probably emerging.)

Below we note three areas: uses of virtual worlds by enterprises such as banking, educational institutions and investment by venture capitalists.

First, Figure 1 is a snapshot of what financial institutions were contemplating as compiled by IBM in late 2007. We suspect that, given the lag time to compile some of this data, that this is no longer accurate. It does reflect, however, the trends we see (for instance in the oil industry, in which firms are exploring applications). They are listed below in the order of interest, with marketing/branding and training/ education at the top of the list.
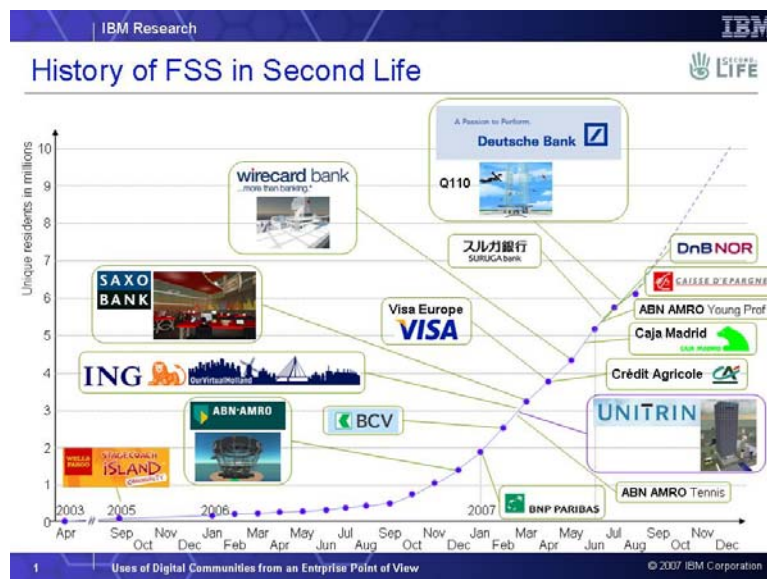
Figure 1:Financial Institutions Active or Contemplating Activity in Virtual Worlds

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[3] Key websites (such as Virtual World News above) give us a day by day accounting. The Federal Consortium for Virtual Worlds http://www.ndu.edu/IRMC/fedconsortium.html is a good place to track examples for the US Government.

Educational institutions have also been engaging in this space. Their uses range from holding classes in a virtual world space, to building out whole campuses. The leading organization that tracks activity is the New Media Consortium— nmc.org. Another helpful portal here is New Business Horizons <http://www.nbhorizons.com/list.htm>, which lists organizations that have builds in virtual worlds. Similarly, investment by venture capitalists (VC's) in this space continues, and the website Virtual Worlds Management <http://www.virtualworldsmanagement.com/research/index.html> provides an up- to-date picture As this last site demonstrates most investment by VC's as of late 2008-9 is in the entertainment space, especially in the Net Gen or "youth " market – game virtual worlds, which we are not summarizing in this paper. This is not, we believe, an indication that using virtual world builds for real work is a bad idea—but rather that lack of middleware to support easy

> **Terminology**
>
> **Build** An instance of a particular virtual world or environment, built upon a specific platform to accommodate users for some purpose, e.g. Almaden Island within Second Life, or one of several rehearsal studios we have constructed there.
>
> **Platform** The software used to create a particular virtual world and environments within it, e.g. Second Life (Linden Labs), Olive (Forterra Systems), Active Worlds (The Active Worlds Company) and Qwaq Forums (Qwaq, Inc.).
>
> **Synthetic World** A broad class of persistent, multi-user, information visualization, exploration and decision spaces providing analysts with the capability of bringing together n-dimensional data (both factual and hypothetical) from a variety of sources and presenting these data within the context of a consistent user-interface and CONOP.
>
> **Virtual Environment** A perceptual field of data derived from any synthetic world providing the user with some type of immersive (usually 3D) experience, with look-around and exploratory capability. For the purposes of this paper, we use the term to refer specifically to virtual world environments—that is, virtual environments derived from or situated within virtual worlds.
>
> **Virtual World** A class of synthetic world making use of an explicit geographical or geo-spatial metaphor and avatar-mediated interaction (what we also describe as mimetic), for the purpose of this paper not including massive multi-player online games (though both are often included in general usage). see also build, platform

design and maintenance has not yet allowed these markets to develop.

Is this state of affairs overwhelming? Certainly. Can organizations wait to let the market make choices? Not if they want to help shape the space. Not if they want to stay relevant to generation Y, or the Net Geners. Or, for that matter, the rest of the planet.

Drawing from cognitive science and cognitive neuroscience, anthropology, AI, even architecture and the emerging discipline of service science, we sort out basic building blocks and levels of abstraction that may prove useful in design and development. From experience designing in these platforms (the authors have nearly two years developing in virtual worlds for enterprise applications), we can begin to discern pretty good, if not best practices. And we can begin to frame the interesting research questions that arise in the context of their use in intelligence analysis.

In what follows, we approach these building blocks (the affordances presented by virtual worlds) in terms of a set of experientially and perceptually basic constructs that relate to environments, our presence within them and the types of objects and things we encounter therein. We argue that, combined with the

pervasive "digitalization of interaction"[4] inherent in virtual worlds, these building blocks become the handles that allow us to leverage innate human cognitive architecture—as it has evolved over the eons—to make the most of virtual worlds' possibilities. We articulate a number of these possibilities in light of what we have taken to be the essential challenges presented by intelligence analysis as a complex and sophisticated form of knowledge work.

The framework of affordances proposed here is a part of a design scaffold. As such, we recommend not trying to design from the affordances directly. This means not jumping directly from the affordance to a particular instantiation for an analyst. Rather, in order to proceed to design for intelligence analysis in a disciplined and research-based way, we suggest a more thoughtful process in which a designed virtual world environment is arrived at through several conceptual stages.

We believe clarity about what it is one is trying to accomplish and why, along with a framework for understanding precisely which attributes of virtual worlds are most likely to promote the relevant cognitive work (both individually and collectively), will provide a rigorous basis for a measurable research program. In sum, we present in this paper a research-based model of the virtual world space, illustrating how its technologies (alone and in combination) could be used to radically transform the ways in which intelligence analysts encounter data, frame their stories, and share their analyses with both their customers and other analysts.

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[4] Digitalization (of interaction) That which occurs natively in a digital form. McQuail, D (2000) McQuail's Mass Communication Theory (4th edition), Sage, London, pp. 16-34.

2. AFFORDANCES OF VIRTUAL WORLDS

In this section we explore some of the distinctive characteristics of immersive virtual worlds that make use of (1) an explicit geographical or geospatial visualization metaphor and (2) avatar-mediated, multi-user interaction.[5] We believe these types of "mimetic" virtual environments offer potential benefits for knowledge work in general, and more specifically with regard to intelligence analysis.[6]

In the model, we use the concept of *affordance* (Gibson, 1979) to refer to the latent possibilities for action presented by an artifact, tool or environment. If not familiar with this concept, think about, for instance the affordances of a chair in the real world. Among the many affordances a chair has is that it makes possible sitting down, standing on it to reach something, or propping open a door. Of course, the affordances of something—anything—are potentially infinite; they are culturally mediated and strongly shaped by awareness, convention and prior experience. When considering affordances of virtual worlds, we look first to those that evoke similar affordances in the real world. The power of mimetic virtual environments stems from the fact that they leverage familiar patterns and modalities, but also allow for systematic violations of the constraints that normally prevail in reality. (For example, as afforded by some virtual world platforms, avatars can walk, point and gesture, but are also able to move about by flying and teleporting.)

In thinking about these types of affordances, we take the view that human cognitive architecture has evolved to take advantage of the types of sensory inputs we receive through our perception of environments, ourselves and other people within these environments, and the presence of various objects, artifacts and things. In fact, entire branches of cognitive science have developed along each of these dimensions over recent decades, e.g. situated cognition (Clancey, 1997), social cognition (Nye & Brower, 1996), embodied cognition (Clark, 1997) and distributed cognition (Hutchins, 1995). Together, these perspectives reveal the varied and complex ways in which human beings extract relevant information and use environmental resources to reduce cognitive load and focus their attention to accomplish a stunning array of tasks. We also see that information has a "social life" (Brown & Duguid, 2000), insofar as the meaning that information takes on is based on context—both immediately present and historically and socially available. The reality of social interaction in virtual worlds provides significant support for people to make sense *together* of the information they encounter.

We will describe the environments, self-representations and things encountered in mimetic virtual world as *metaphors*. Here we refer not to a figure of speech but to a deeply-rooted cognitive process of mapping from a source domain to a target domain (Lakoff, 1993, 1987; Fauconnier & Turner, 2002). In cognitively significant metaphors, the source domain is always perceptually more basic than the target domain, allowing understanding to be boot-strapped from embodied experience to more abstract concepts. In the case of mimetic virtual environments, the source domain is all our everyday embodied experience in spaces, places, landscapes, and interaction with other people as well as objects and things. The target domain is computer-mediated, multi-user interaction. Leveraging this type of metaphor effectively transforms embodied experience into a tremendous resource to make multi-user interaction more fluid and intuitive.

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[5] We concentrate here on a variety of non-game platforms to avoid vexed questions (unhelpful for our purposes) about the proper relationship between play, games and "real" work.

[6] There are a number of essential or foundational attributes, including persistence and 3-dimensionality, which we do not explicitly address because they are clearly assumed within the definition of synthetic worlds laid out in the context of the A-SpaceX program.

In what follows, we describe a number of the affordances natively available in virtual environments. We depict the way in which the basic affordances of virtual environments have been recombined and partially "sedimented" into a secondary layer of *constructed* affordances, relatively likely to be found in one form or another across platforms. The relationship between native and constructed affordances is more complex than we can easily do justice to—in most or all cases, each constructed affordance depends upon several native affordances, connected and combined in different ways.[7]
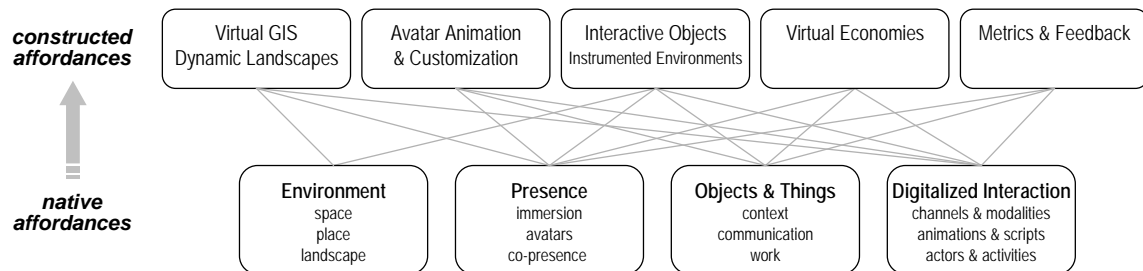
Figure 2: Native and Constructed Affordances

We have chosen to parse the space of affordances this way because these are perceptually basic categories, each with different metaphorical grounding, and distinct cognitive architectures (evident on the basis of diverse evidence ranging from developmental studies to fMRI imaging). These two tiers of affordance provide a range of potentially useful cognitive supports for individuals engaged in knowledge work such as intelligence analysis.

Affordances of Environment

Virtual worlds of the type we are considering utilize some form of more-or-less literal spatial representation of conventional, recognizable three-dimensional environments. We parse this attribute into three categories of affordance: space, place, and landscape. Each has a distinct scholarly literature, with insights available from fields as diverse as architecture, economics, and human geography.

Space

Cognitive processes where once understood as solely confined to the brain. We have come to see that (in addition to the social processes we alluded to above) cognition has evolved in tandem with our bodies and the various modalities we have for moving within and interacting with our environment (Clark, 1997). At its core, space is about movement—or rather possibilities for movement and different ways of encountering entities and information around us. Navigation is the act of contemplating and executing movement in light of our intentions and the environmental particulars arrayed before us. The importance of movement and navigation are reflected in complex neural pathways devoted to spatial navigation, object manipulation and visually-guided action that activate many areas of the brain implicated in canonical cognitive processes such as memory and intentionality (cf. Squire et al., 2008, Brotons et al., 2005).

The concept of space invokes a number of related ideas including dimensionality, scale and perspective. Though we tend to think of these notions as objectively given, our understanding of each has evolved

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[7] Again, following W. Brian Arthur's notion, this recombination reflects the *encounter* between users and the various purposes to which they have adapted and put virtual worlds to use.

substantially over time.[8] Spatially-informed representational techniques engage the thoughts, emotions and imaginations of viewers—in essence by reproducing or mimicking perception and queuing actual embodied experience. We now have a rich language of representational precedents that can be coupled with sophisticated mathematics, allowing us to use changes in scale, viewpoint and perspective to render complex information intelligible, intuitively meaningful and compelling.

Similarly, many base-level linguistic metaphors we use to structure abstract concepts are also grounded in bodily experience (Lakoff, 1987), making it relatively easy and natural for us to associate spatial directions with particular meanings (such as using the direction "up" to suggest "good," or "more"). These principles of spatialization can and are applied in information design to enhance clarity and understanding. However, beyond this there is reason to believe that the type of literal spatiality and intentionality of movement that characterizes virtual environments can positively impact cognitive processes, ranging from perception, to memory, inference, reasoning and learning.

Place

Whereas "space" connotes emptiness and highlights potentialities for movement, "place" encompasses the various ways—individually, collectively, and culturally—by which we imbue particular environments with meaning. Space and place have a reciprocal relationship. If truly empty and undifferentiated, space itself is not very interesting (even if one can move freely). Conversely, places become meaningful in their distinctness from one another—through our ability to move between different places, finding ourselves in one place rather than another (Cresswell, 2004; Tuan, 1977). Thus place entails localization, boundary and variety, in addition to the particulars of how any given environment is populated.

Place creates a context for activity, and activities are often localized to different places. Cognitively speaking, place also encompasses ways of structuring environments to make them familiar and useful. At an individual or micro level, this may be manifest in the layout of a particular room—such as an efficient kitchen—or an office that affords interaction by virtue of proximity and routine. It applies as well at more macro, collective levels, to neighborhoods and even cities, where essential, productive dynamics occur between residents of a particular place and those who routinely pass through (cf. Hillier & Hanson, 1984; Fujita et al., 1999).

Landscape

Whereas space and place exist in tension, and in a sense define one another in terms of movement, landscape invokes a tension between near and far, between the distal and the proximal. It encompasses the ways in which terrain affects where people choose to go, as well as the imprint human activities leave over time (Wylie, 2007).

Landscape provides context for place, exerting a powerful effect on the forms of settlements and the types of activities that take place within them. Variations in terrain and geographic features such as bodies of water lend character and feel to an environment, creating vistas or constraining access to make some areas more hospitable, accommodating or advantageous than others. Thus, landscape shapes human awareness and activity, both on affective and pragmatic levels. Landscape is in turn *shaped* by human presence in various ways—obstacles are erected or removed, infrastructure is put in place and movements leave traces, making visible aggregate patterns of presence and activity.

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[8] As Wertheim (1999) recounts, the notion of space as empty or void was abhorrent to many thinkers in classical antiquity and, arguably, the first form of virtual reality can be found in early renaissance perspective painting.

Constructed Affordances: Virtual GIS and Dynamic Landscapes

Building upon the native affordances of space, place and landscape, a number of useful features have been developed for users of virtual worlds. Because precedents have been established for these types of functionality and variants are available in a number of virtual worlds, we refer to them as "constructed" affordances, of which we will discuss two. This by no means exhausts the realm of possibilities, as we will get into in the section that follows.

The first of these constructed affordances is what we refer to as virtual geographic/geospatial information systems (GIS). These are ways of overlaying information, statistics and other symbolic content pertaining to inhabitants and activities in various spaces and places, on a pictorial representation of the virtual landscape. When the pictorial representation takes the form of an aerial photo or bird's eye view, we recognize a map in its canonical form (MacEachren, 2004). However other types of representation fit this bill as well, such as making the walls of a building transparent to see what's inside, or using a "heat map" to visualize database distribution, software utilization and energy consumption in IBM's virtual green data center[9]

Dynamic landscapes are landscapes whose features can be altered to reflect the state of some activity taking place, either within the environment or in another environment, as a way of providing feedback. Take for example, an IBM-internal software development environment built on a virtual world platform known as "Bluegrass," in which projects were visualized as large trees and the software developers involved were represented by avatars and workspaces. Around each work area, the height and color of clumps of grass gave an indication of the number and severity of issues each developer was working on. Use of the landscape metaphor allows participants to rapidly and intuitively understand who is working on what, and where trouble is occurring.

Both virtual GIS and dynamic landscapes essentially depend upon the native affordance of digitalized interaction, which we will describe more fully below.

Affordances of Presence

Whereas 3D environments present certain categories of affordance to us, *presence* denotes our subjective experience within these environments, including our awareness of others and their awareness of us. Presence is commonly understood in terms of a participant's sense of "being in" a virtual world, of the reality of that world and of other people and characters within it.[10] Developmental studies and brain imaging underscore how these types of sensory inputs serve to anchor our sense of ourselves and underpin the understanding and empathy that enables us to engage with others (Decety & Meyer, 2008; Decety & Sommerville, 2003). Below, we relate the sense of presence in virtual worlds to three distinct sources: immersion, avatars and co-presence.

Immersion

Immersion is the experience, obtained through sight, sound and even "touch," of being surrounded by the content of a virtual world (Steuer, 1992). For years this was sought through higher resolution and wrap-around or head-mounted displays that would react to a wearer's movements. More recently however,

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[9] IBM's virtual green data center: http://www-03.ibm.com/systems/greendc/resources/info/vgdc/
[10] Semantic differential scales employed by Schneider et al. (2004) are discussed by Lim & Reeves (2007). These reflect the degree to which participants perceive themselves to be in a different place, the reality of that place and the reality of other people and characters in that place.

evidence has accumulated that significant immersive experiences can nonetheless be conveyed through conventional laptop screens and systems with relatively low level of graphical sophistication (cf. Taylor, 2002). The feeling of immersion is enhanced by the ability to interact with objects from all sides. For example, interacting with a 3D representation of a server in a virtual data center is palpably different from interacting with a textual description on a screen.

Virtual worlds can create a heightened sense of immersion by virtue of opportunities presented to the user for navigation and engagement with items in a visual scene. In addition, as Thomas & Brown (2009) point out, virtual worlds afford—and indeed, very often *require* us to engage in synchronous interaction with other individuals. This type of engagement results in characteristically heightened physiological responses and patterns of brain activation (Lim & Reeves, 2007; Chaminade et al., 2005). One of the advantages of using virtual worlds for learning or simulations is the ability to create an experience of engagement with the task, with the surroundings and with other participants that offers a greater potential for transferability of learning back to the real world.

Avatars

Using an avatar, a digital representation of the user, is central to the experience of being immersed in a virtual environment. Avatars create an embodied presence for users in a space of social interaction, allowing them to communicate non-verbally through gesture and physical proximity to one another, as well as allowing others to recognize them, infer their intentions and provide accountability for their actions (Taylor, 2002; Moore et al., 2006). Furthermore, evidence suggests the rules governing these virtual interactions carry over from the real world (cf. Bailenson & Yee, 2005; Yee & Bailenson, 2007; Yee et al., 2007). Most virtual worlds allow the user to take different perspectives on interaction occurring between avatars, including first person, third person, bird's eye or mouse views. The ability to change perspectives can be enormously important for learning and for analysis of data and information, and is something that cannot be easily performed in the real world without additional technology.

Having a digital self-representation can be important for a number of other reasons including self-expression, the manner in which people choose to characterize themselves. As Bainbridge (2007) notes, significant differences in the psychological distance users maintain between themselves and their avatars in virtual worlds (as compared to characters in multi-player online games) opens up a rich area for study and is likely to have many implications for interaction. Users have complex cognitive and emotional relationships with their online avatars, which may be crafted to reinforce or differentiate various aspects of their identities (Turkle, 1995; Messinger et al., 2008). Identity, personality, and affiliations can all be depicted by aspects of the avatar manifestation. A benefit of being able to select a self-representation is that it offers users a chance to project a certain appearance, change and experiment with identities. This can be useful for role-playing and learning, as we discovered in the case of one participant in a virtual learning environment we developed for project managers who reported being excited by the opportunity her avatar gave her to be more outgoing and assertive than she felt she otherwise would have been.

Co-Presence

Lastly, a third advantage of having an avatar as a self-representation in a virtual world is that users have the ability to interact and communicate with other users (represented by avatars themselves) in a contextually-rich environment. "Co-presence" has been used to describe the degree to which people feel present with others in virtual space such that the medium of communication fades away and the user feels that an unmediated interaction is taking place (Dourish, 2001; Schuemie et al., 2001).

When avatars can direct attention based on a variety of communicative cues, there are a variety of advantages to focused attention such as accountability from others to engage in the interaction, immediacy of a response, and shared context for the conversation. Co-presence is essential to socializing and a variety of learning approaches that rely on real-time, contextual interactions such as role-playing, shadowing, and group simulations. Thomas & Brown (2009), though admittedly referring more to MMOGs like World of Warcraft than to non-game worlds, highlight the possibilities for collaboration we believe these worlds present, and the potentially great impact these experiences can have on individuals and collectives:

> *This sense of coordinated interaction with others produces more than just social interaction or conversation. It allows for a deep sense of presence that is akin to what Michael Polanyi called 'indwelling,' a tacit understanding and construction of the world, people, and practices that define experience and embodiment.*

<div align="right">Thomas & Brown (2009), p. 20</div>

Constructed Affordances: Avatar Customization & Animation

Many virtual worlds allow users to have multiple avatars, to customize their avatar, and allow their avatars to transform into any form, human or non-human. This allows for quite a variety that could be useful for a number of reasons such as self-representation, agent representation, or role-playing. It is unclear as to the extent that avatar customization is important to users, but there is certainly a great deal of effort put into this activity as well as thinking about the tools and types of customizations that should be available to users to perform the customizations (Boberg et al, 2008).

It is quite common for virtual world users to have multiple avatars, one of the avatars is typically designated as the "main" avatar and the others are "alts" (alternate characters). In a research study, Ducheneaut et al (2008) surveyed users from three virtual world platforms: World of Warcraft (WoW), Maple Story (MS), and Second Life (SL). Ducheneaut found that on average, users had 8.08 avatars per account (WoW: 12.30 avatars, MS: 5.22 avatars; SL: 2.92 avatars). In addition, since SL users are able to customize the look of each avatar, these users kept an average of 40.76 "outfits" stored in their inventory. It is important to note that SL outfits could be any number of things related to the avatar's appearance such as clothes, body shape, and body parts that can be stored separately or as a combination, which allows users to quickly switch their avatar's appearance.

Affordances of Objects & Things

Virtual worlds are populated by a potentially vast number of things that convey a wide range of information, limited only by the creators of a virtual world and/or by the creativity of users. These objects range in purpose and functionality—some things an avatar might encounter serve to provide information and give context about an environment, some objects are created to facilitate and promote group interactions, and some objects are created to help avatars do "real work" in virtual worlds (work both individually as well as within a group for collaboration).

Giving Context to Place

Objects and things are often introduced in virtual worlds to give users context about the places they are occupying. The advantage of using objects for this purpose is the information can be sensed intuitively and immediately with basic visual and auditory perception. Surprisingly rich information can be

conveyed through objects' placement in an environment, and the creativity evident also tends to engage participants in extracting meaning and interpretation. For example, in a recent rehearsal studio, we populated the environment of a virtual factory distribution center with the kinds of things one would see in that environment to help participants in a learning simulation understand what the place was, and to provide clues as to the types of problems central to the exercise. Not only was this more interesting for participants than reading text descriptions, it engaged their powers of observation and problem solving in ways that were directly relevant to real-life work situations.

Just as environmental affordances are aligned with cognitive architectures in the human brain to help create cognitive scaffolding (upon which we build immersive experience), objects in virtual worlds help with the understanding of the world by taking advantage of the distinct cognitive architectures associated with object manipulation for visuospatial processing. It is common for people to manipulate views of objects in the real world either physically (e.g. rotate an object in a hand) or mentally (e.g. mental rotation) in order to get a better understanding of the object. In fact, mental rotation of objects is an important visuospatial ability thought to underlie basic skills such as problem solving and spatial reasoning (Shepard & Metzler, 1971), and the pattern of neuronal activation for the mental rotation relies heavily on motor areas of the brain (Zacks, 2007). Mental rotation is used to compensate for not being able to move around in the world and change viewpoints, but virtual worlds with 3D objects change that – they allow us to see different viewpoints by manipulating camera angles, virtually rotating objects, and moving our avatars around to get different perspectives, thereby easing cognitive load by helping with basic visuospatial processing.

Facilitating Interaction and Communication

Beyond casual social exchanges, when people get into substantive conversations, a lot of gesturing and pointing tends to show up. Having access to objects and things in a shared environment is important to ensure alignment and adequate common ground for conversational coherence (Clark, 1996; Clark & Brennan, 1991). One of the best ways to make sure people are talking about the same thing is to give the thing being talked about (or a reasonable proxy thereof) a physical or visual presence in the environment. Contrast such a situation with a telephone conversation, where referential ambiguity runs rife.

Of course, the communicative functions of objects go well beyond providing shared reference. Artifacts like texts and presentations are designed to carry information, to convey experience, affect belief and (perhaps) alter behavior by virtue of their symbolic content. When brought into the virtual environment, the content of texts and other media artifacts is often projected or displayed on a surface to mimic a screen—in which case the content-bearing screen becomes an object in the shared environment. Other objects may be interactive, performing some behavior when clicked or "touched" by an avatar. So, for example, interactive objects might be encountered that are able to display instructions, provide information about themselves, play a media clip, etc.

Doing "Real" Work

Most virtual worlds have been primarily used as social environments up until a couple years ago. When enterprises launched into this space (IBM's official foray into virtual worlds was in November 2006), analysts wondered if this space could actually do "real work." Would it be more than just a game? In order to do work in virtual worlds, new businesses opened up to create settings that were fitted with conference rooms, offices, computers, and so on. Things like business event management became popular. One of the questions that still remains is, "What kind of work will people do in virtual worlds?" Will they go to work just as they do in the physical world, or will it be different, perhaps an augmented

version of the work they do now. Will work be integrated in both physical and virtual worlds? In any case, objects have to be created to support, promote and actually carry out the work that people do in virtual worlds. These include objects that help accomplish work individually and collaboratively, representations of the work itself, and things that might guide processes and methods.

An important class of work-related artifacts in the real world is tools that extend human capabilities and create new ones. Since virtual worlds aren't subject to the real-world physical constraints, there's not the same need for wrenches and screwdrivers. However, objects still provide useful ways of localizing or crystallizing functionality—sometimes quite complex functionality—so that it can be conveniently accessed, and provide information to users as well as others in the world. An example close to home in software development: one of our colleagues found that associating a particular debugging mode with a "bracelet" his avatar could wear made it easier for him and others to keep track of when this functionality was enabled. Besides tools, another important class of work-related artifacts are those that embody objectives and outcomes or that guide work processes. Examples include various kinds of drawings, models & prototypes & plans that are essential to the conduct of work in the real world. At present most of this work still takes place outside of virtual worlds, but as in-world tools become better and virtual environments are used for synchronous collaboration, the creation of objects corresponding to work outputs will be increasingly important.

Of course, by no means all objects created by users in virtual worlds are for work—in fact, at present the opposite seems to be true. However virtual worlds have undeniably provided a vehicle for people to engage in creative *content* production of many kinds that, by virtue of desirability to others can be shared, given, or *sold* by their owners. And this does not apply only to objects—which brings us to the rich subject of virtual economies.

Constructed Affordance: Virtual Economies

The economist, Edward Castronova, wrote the first serious book on virtual economies: *Synthetic Worlds*. As he points out, people have wildly different reactions to the idea of a virtual world economy. Some think they don't have real economies. Some think they do. But for those of us who are not economists, his perspective is helpful.[11]

According to Castronova, once you have two of our native affordances "co-presence" and "objects" that can be operated on, you have sufficient conditions for a virtual economy.

> *Like the rest of us, users of synthetic worlds have to choose how to allocate their time. They have to decide what worlds to visit, and once in the world, they have to decide how much time to spend doing different things. Its part of the deal we all got when we became human beings. Thus choice under scarcity [the traditional area of study in economics] happens whenever a human decides what to do. The economy 'happens' in that moment. In other words every synthetic world has always had an economy, without exception.*

> Castronova (2005), p. 173.

There are two consequences that emerge. One is the opportunity that is generated by an economy, namely that of synthetic or virtual currencies. By synthetic currency we mean something like Linden

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[11] For Castronova, synthetic worlds include not only the virtual worlds we address in this paper, but also MMPORG's, Massively Multi Player On-Line Games such as Everquest and World of Warcraft

dollars in Second Life, which is pegged to the US dollar. People use Linden dollars to buy customized outfits for their avatars, for houses, and everything to furnish them (if you don't know about this phenomenon, it may seem startling that people pay real money for virtual stuff). How big is the virtual economy in "real" dollars? Castronova's estimate in 2005 was that (games and virtual worlds included) around a billion US dollars (and includes trading in synthetic currencies). The sum is surely much higher now. Even then it was more than the GDP of small countries.

Acting in these virtual worlds has another parallel to a "real" economy as reflected in the time people spend there. Time in a virtual world is a scarce commodity just as it is in the real world. Indeed, there is a curious phenomenon called "camping" in which real people are paid (in a synthetic currency) to "seat" their avatars in a chair so that a virtual world environment is visibly populated.

Finally, without venturing too far into the world of synthetic currencies (which we address subsequently) it is worth noting that there are real costs associated with serious development in these virtual worlds. Even though Linden Lab's Second Life is free, until you want to have land, for instance, someone or some organization has to spend money. Companies such as Electric Sheep will build a virtual world, but you have to pay them in real money to do so. It is safe to say that the market has not yet settled down for this kind of virtual world development, and so we do not attempt to say anything here. [12]

Affordances of Digitalized Interaction

In the previous sections, we described the avatars who inhabit virtual worlds and the objects they create to give context to their environment. Since the avatars, objects, things in the world, and the environment—all of the native affordances—are *digital*, there is an amazing opportunity to collect and analyze information. This offers us, researchers, practitioners and analysts, a world of opportunity to understand interactions (notably, not just objects or avatars anymore, but the interactions that evolve from their exchanges) that have taken place in the past, optimize those in the present, and improve those that might take place in the future.

Multiple Channels & Modalities

Virtual worlds provide a number of distinct communication channels, allowing participants to choose the most effective modality in any given situation, and offering ways of directing communication to others in ways that are not possible in the real world (without juggling an armload of devices, at any rate). Text-based communication between avatars and objects (and any combination of those two: avatar-to-avatar, avatar-to-object, etc) can occur on a number of different channels. Second Life (SL) offers 12 different text channels, akin to different radio signal frequencies, that allow for public broadcast and private messaging. There are generic text chats (publicly seen by anyone within a certain radius), private text chats (instant messages that are seen only by the intended recipient), group messages (messages that can be broadcast to a group of users or to all avatars on an island), as well as Voice over Internet Protocol (VoIP) used to replicate proximal spoken communication and telephone calls.

In addition, other modalities of communication (e.g. non-verbal communication) can be performed such as gestures, proxemics (i.e. the "personal distance" between avatars), eye gaze (in SL, if an object is touched the avatar will appear to look at the object, and the eye gaze is also related to the position of the mouse cursor), and appearance (e.g. in SL, since clothes are part of avatar's inventory, types of clothes

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[12] See http://virtual-economy.org/bibliography for an up to date (as of the writing of this paper) list of publications and manuscripts on virtual economy.

worn can be captured). Most virtual worlds support some form of recording of rendered 3D graphical output from a particular point of view ("machinima," analogous to a movie); more sophisticated capture of the time-based specifications and events in the underlying 3D data stream allows a 3D scene to be recreated and replayed, viewable from any angle.[13]

Avatars, Animations & Scripts

Furthermore, the environment can be instrumented to collect information such as which avatars are present in a particular space, where they go, how long they linger. Avatar behaviors are themselves also digital, often comprised of short pieces of programming code, or scripts, used to automate movements and gestures. Include which avatars are interacting with which other avatars and what objects they are each interacting with and for how long (and, since many objects also contain scripts, we can document which scripts are executed and by whom). We can record basic avatar activities about what they do – do they walk, do they fly, do they teleport, do they sit? Additionally, we can see what they create (build) and, in virtual worlds with a currency, we can see how much they pay for it. We can see who gives, without remuneration, something to someone else.

Virtual worlds are witness to complex social interactions, involving large numbers of participants that resemble in many ways those occurring in the real world. The possibility of designing rigorous experiments with the enhanced observation and data collection afforded by digitalized interaction prompted William Sims Bainbridge, Director of the National Science Foundation, to advocate for virtual worlds as potentially transformative laboratories for social science (Bainbridge 2007).[14] It is quite evident that the possibilities for information gathering are endless, so the key to uncovering valuable insights is to gather and analyze "strategic" pieces of information, which requires some advance research and planning and "intelligent" data mining. Designing virtual world builds with data collection and analysis in mind is, therefore, extremely critical.

Constructed Affordances: Instrumentation, Metrics and Feedback

Let's now explore some constructed affordances that can be built on the basic affordances of digitalized interaction. The possibility of associating scripts not only with avatars but with objects and even environments, opens up various possibilities for instrumenting the worlds to acquire information about the interaction that is taking place and feeding this information back to participants. Nowhere has this been taken to such a high level as in massively multi-player online games (MMOGs).

In their study of what makes multi-player online games so interactionally compelling, Reeves, Malone & O'Driscoll cite the pervasive availability of statistics on numerous dimensions of game play and the rapid feedback players receive on their individual and collective performance as essential ingredients. This timely feedback, along with the clear objectives inherent in game play, support a vibrant and rigorous meritocracy and flexible leadership structures the authors argue will be increasingly characteristic of real workplaces in the 21st Century.

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[13] We should emphasize that, while this information is all digital and part of the data stream flowing between virtual world participants and the platform servers, platforms differ in the extent these data are made readily available for logging and capturing.

[14] Bainbridge suggested not only recreating classic experiments to test replicability of their results in virtual worlds, but also the possibility of delving into areas of human and social science that have remained stubbornly fragmented to date, such as those that revolve around disparate conceptions of "self" and "identity."

Here are a couple of examples from our work in building virtual environments in Second Life at IBM. Figure 3 shows two views of a team room in a learning simulation for project managers. First, imagine for a moment that we could capture all this data as easily in real life: we could collect all telephone conversations, all chat, all IM. We could track who was talking with whom and for how long, see what objects they interact with, where they go and what they do there. Of course, privacy issues are just as significant as they are in the real world. Relying on transparency and informed consent, we have found participants willing to share substantial data for the purpose of understanding collaboration.

However this data collection is not only useful for researchers and observers. Instrumentation can provide useful feedback to participants themselves. For example, we created an activity ball that changes color based on the amount of conversation occurring in a conference room—in a sense, indicating the level of engagement in conversation. In another build, we designed a footprint path based on the number of avatars that had visited that spot. The footprints faded over time, but a path that was well-worn indicated that many people had visited.

Figure 3: Two Views of an IBM Team Room in a Learning Simulation in Second Life

It is also possible to embed mechanisms for acquiring meta-interaction data and providing feedback directly in the participants' UI as well as in world. For example, we created a rehearsal studio in SL specifically designed to help project executives (PEs) practice client negotiations. In this rehearsal studio, a PE has the opportunity to practice with a coach (in real-time, avatar-to-avatar), the coach role-plays the client. There is also space for avatars to observe the practice session, which is advantageous to those who would also like to take a turn and practice. If this was an out-of-virtual world negotiation, the PE would be able to see the client's and observers' reactions (non-verbal communication) to his negotiation tactics; therefore, in SL, we gave the coach and observers Heads-Up Displays (HUDs) to easily provide real-time feedback and display their natural reactions to the negotiation. The HUD both animated the avatars with gestures (nodding or shaking their heads), but they also served a secondary purpose that allowed us to collect data on the interaction. The HUD captured all the reactions, which provided the capability to create a graph of the reactions over time overlaid with a timeline of the video of the negotiation. The PE and observers could then easily see when the negotiation was going well or not-so-well (based on the "crowd" reactions) and review that portion of the video.

Summary and Research(able) Questions

Before proceeding to discuss how the affordances above might be combined and deployed to better support the challenges of knowledge work in general—and intelligence analysis in particular, we'd like to take stock of the ground we have covered. First, a quick review of the substantial questions that have arisen that, though they may be complex and not easily answered, are at least in principle *answerable* on the basis of empirical evidence and sound design.

How does intentionality of action and navigation in virtual worlds alter an individual's relationship with information they encounter therein? How might spatialization of information or activities within the analytic process convey actual advantages—for example, by providing experiential grounding for the "Mind Snap" concept? How might virtual places and landscapes shape or interact with individual or collective thought processes either to focus interaction or suggest new possibilities?

How does person perception interact with the process of meaning-making? How might personification of information or (i.e. attaching a person's identity, either real or fictitious) to a particular position, interpretation or conclusion alter the way others perceive or value that information? On the flip-side, when might anonymity be useful? What kinds of latitude and experimentation in terms of behavior and identity might avatars afford? In what ways could this be relevant to knowledge work and intelligence analysis?

What is the nature of the relationship(s) between us and our avatar(s)? If it is indirect, do we need to worry about privacy? If it *is* indirect, can we actually infer anything about the person behind the avatar? What if the relationship is more direct? What can (and will) people infer from the behavior of the avatars of others in a particular situation? How much observation and data collection will people tolerate before taking sensitive-yet-essential aspects of their work practice into other venues, thereby undermining the efficacy of the technology?

How does multi-user interaction and real-time co-creation of content of the type that appears possible in virtual worlds contribute to individual and collective performance and correlates in areas of identity, cohesion and self-efficacy? In what ways can virtual worlds support learning and education models that are more collective than they have been in the past, without sacrificing accountability and support for individual learners? What types of content should be brought in to the virtual environment to enable

individual and collective performance for those trying to do real work? What might be extraneous, what is essential to preserve in light of bandwidth and processor speeds that are never enough? What is the best way to accommodate expertise and practice intertwined with legacy systems and specialized tools?

The following table summarizes the types of benefits the affordances we have outlined above can potentially convey to knowledge workers (such as intelligence analysts) carrying out all or part of their work in a virtual world. We argue that knowing how to deploy these, cogently and intentionally, to promote particular types of cognitive work (played out both individually and collectively) will be essential to make use of the potential virtual worlds offer.

Table 1. Affordances of Virtual Worlds and Potential Benefits Conveyed

affordances (native & constructed)	*potential benefits*
Environment space place landscape	• enhanced salience & memorability • use of scale, zoom and perspective to enhance understanding • effective functional arrangements and contextual associations • orientation, schematization (i.e. directionality = intentionality, centrality = focus)
virtual GIS dynamic landscapes	• synoptic (overview) spatial awareness • diachronic (longitudinal) temporal awareness
Presence immersion avatars co-presence	• embodiment, perspective, involvement in a situation • self-expression (& impression creation) • awareness of presence of others, proxemics • person-to-person engagement, accountability • identity vs. anonymity
avatar animation & customization	• interactional fidelity and responsiveness • malleability of identity, role & character
Objects & Things context communication doing work	• intuitive awareness & intelligibility of situations • inter-subjective grounding & shared reference • capture & reuse of functionality • content creation, ownership vs. sharedness
virtual economies	• allocation of scarce resources (including time and attention) • value-based exchange and market mechanisms
Digitalized Interaction multiple channels & modalities animation & scripts	• flexible awareness & signaling • broadcast vs. narrowcast messaging • recording & playback • behaviors as specifiable, exchangeable goods
instrumentation, metrics & feedback	• monitoring, logging & statistics • meta-data, tagging & flagging • reinforcement & improvement; incentives & rewards

3. ENHANCING SUPPORT FOR INTELLIGENCE ANALYSTS

Up to this point, our discussion has been primarily about the intersection of human cognitive capabilities and the technical affordances of the new 3D virtual world platforms. Intelligence analysis, after all, is essentially cognitive work. We laid out a framework for understanding the affordances of the technologies available in virtual worlds in terms of their cognitive import as related to both physical and social aspects of being human. In this third section, we turn to how this technology can be used to enhance support for intelligence analysts. We are mindful of the observation made by the authors of a recent RAND report:

> *It cannot be repeated too often that R&D for the analytic community is not just, or even primarily, about technical tools. It is about training and reshaping the culture of organizations and finding better ways to connect machines to human analysts and those analysts to one another.*

Treverton & Gabbard (2008), p. 36

The extensions of our framework to *opportunities* and *instantiations* respect this admonition in focusing on uses of this technology that support knowledge work, of which intelligence analysis is a sophisticated example. First, from the two kinds of affordance, native and constructed, we lay out opportunities for designing virtual world experiences. Opportunities result from combinations of affordances that the technologies provide. They give additional grist for design rationale and criteria for evaluation.

Then we provide examples of instantiations – how the opportunity might be manifested in a particular platform. This isn't just a needless "academic" exercise in fine-grained analysis. Rather, its motivation is much more pragmatic. Our experience, after working in this medium for over two years with mostly (IBM) early adopters and looking at other virtual world "builds", is that there is temptation to "rush to instantiation." You only have to look at all the work going into showing PowerPoint presentations in virtual worlds to understand that many of the affordances of these new technologies are not yet being taken advantage of.
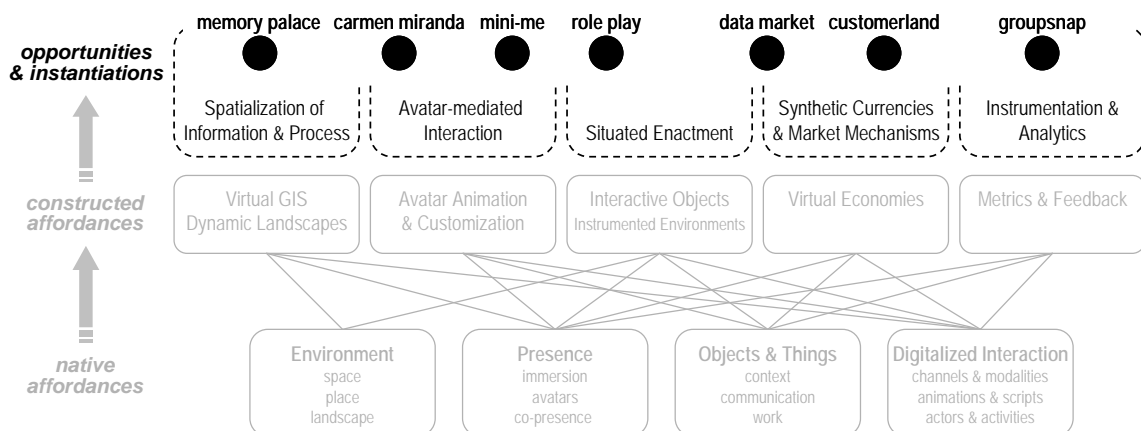

Figure 4: Opportunities & Instantiations (built upon native & constructed affordances)

In short, we present a number of these opportunities in general terms, as outgrowths of the affordances described in the previous section. We illustrate how these ideas might be more freely combined and played out specifically in the context of intelligence analysis with a series of instantiations in side-bars that roughly parallel each topic. These are illustrations only of the richness of possibility, not proposals for specific solutions or configurations.

First though, let's make clear the assumptions we are carrying into this exercise with regard to analytic practice.

Challenges to Current Analytic Practice

While there are no doubt lists upon lists of challenges to current analytic practice, we have concentrated on those described by the A-SpaceX program proposals. Further, we have focused on those that our analysis of current 3D virtual world technologies suggest can be addressed in fruitful ways. Importantly, while it is not always obvious, these 3D virtual world technologies can provide an environment in which the output of legacy applications can be represented in virtual worlds. Figuring out how to select combinations of affordances is the design effort that is needed to make use of the potential these platforms provide.

- <u>Security requirements and a culture that discourages collaboration</u>. While this is largely a matter of policy and practice, the interactive aspects of virtual worlds can promote collaboration and provide a variety of ways in which analysts might drive collection. The digitalization of interaction may even enhance the ability to ensure that information is shared only with appropriately qualified persons.

- <u>Huge amounts of data and ad-hoc responses to information overload</u>. We discuss ways of making more effective use of people's ability to intuitively understand and see patterns in visual rather than textual data due to the affordances of 3D, and of doing this together as well as individually. We believe there is great potential to enhance the ultimate goals of incisive analysis— maximizing insight obtained from collected information in a timely manner.

- <u>Tools that are not optimized to support workflow and creative process</u>: We see potential for virtual world technology to create places where different data sources, as provided by a variety of tools, can be accessed and brought together in different ways. This should make some legacy applications more useful and allow the integration of all kinds of new data that is collected. Having information gathered together in a place also may make it easier to increase ways for analysis to drive collection.

Some elaboration on the points above, which we found in reviewing other public reports on the current state and issues with analytic practice (notably Treverton & Gabbard, 2008, and Johnston, 2005), also seems worth noting. While we are not in a position to know how these specific sources are regarded within the intelligence community, we did extract some key points where they appear to corroborate one another and usefully expand upon the above. We hope that making these assumptions explicit will clarify the thrust of the opportunities and instantiations we describe below.

First, it seems clear that analytic practice is challenged by limitations of analysts' individual, working memories and the need to make meaningful, interpretive connections across pieces of data acquired at different points in time and of widely varying reliability (taking into account attempts at intentional

deception). Particular mention is made of the danger of analysts' falling into any number of "cognitive traps," principally including confirmation bias and mirror-imaging.[15] A profound concern appears to be a tension between the application of rigorous methodologies and robust analytic processes designed to ameliorate cognitive biases, and the intense time pressure analysts experience as a result of the need to stay abreast of large quantities of information and current reporting.

We also found useful elaboration on the need for teaming and collaboration. Imperatives driving this need include the division of labor to address information overload, the cross-agency and cross-domain expertise required to solve problems and the multiplicity of disparate, dynamic and continually evolving threats and interests with which today's analysts are confronted. It was also interesting to note the ways in which cognitive traps can have collective, and even organizational manifestations.
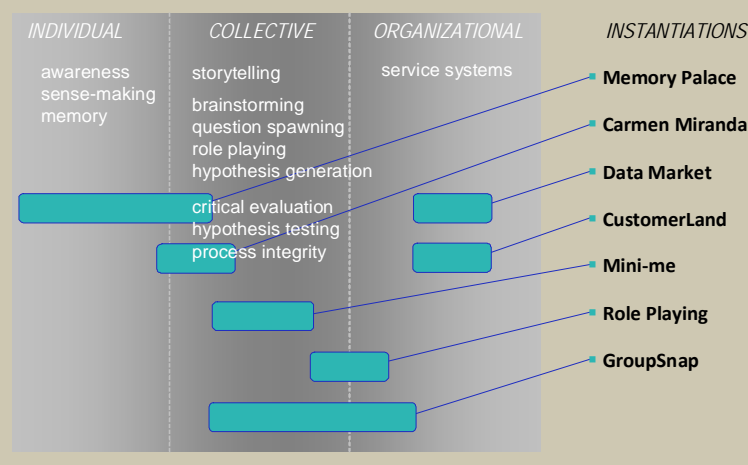
Finally, issues of analytic culture across the intelligence community and the need for enhanced education and training were also identified. In what follows we

Instantiations for Intelligence Analysis

In order to understand how the opportunities discussed in this section might map onto intelligence analysis, we reviewed A-SpaceX materials as well as published accounts describing the nature of analysts' work and the challenges they face. In these sidebars, we offer a series of instantiations. These are intended to illustrate the range of possibilities, not as proposals for specific programs. The diagram below depicts how the various instantiations address issues across individual, collective and organizational levels of work

offer suggestions as to how virtual world technologies can help meet these challenges at individual, collective and organizational levels. We also note how the same virtual environment that analysts work in can be used to share practices and provide novices with experience. Because digitized interaction makes it possible to record and replay interactions, it is feasible to support reflection. Similarly, there are myriad opportunities for apprenticeship, especially as characterized by the communities of practice perspective (cf. Wenger 1998).

It is important to point out that there are existing approaches to each of these challenges. What seems striking to us is the opportunity to quickly design and build innovative work environments using 3D virtual world technology to integrate with existing applications. This sort of thing lends itself well to rapid prototyping and iterative development. It is easy to start simply and add complexity, rather than having to design all the complexity in at once.

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[15] Briefly, the former being the tendency to disregard evidence that contradicts preconceptions and assumptions, the latter being the tendency to overestimate the extent to which others are likely to think and act like us.

Spatialization of Information and Process

Movement through space is a powerful way of structuring experience, and the activity specificity of individual places makes them both useful and memorable. Spatialization of information and/or aspects of analytic process may enhance memory and provide perceptual/experiential grounding to reduce cognitive load in, for example, implementation of the Mind Snap concept (as illustrated in the accompanying sidebar on "The Memory Palace" instantiation). This underscores the importance of intuitive and easy-to-use design tools to allow analysts to build out and customize spaces to meet their needs.

When analysts come together, the shape and character of a landscape might inform what they do together as well as individually—either by associating a directional schema with the direction of workflow or using centrality to reinforce the focus of a particular activity. For example, completion of a process could be associated with reaching a destination, or a transition from hypothesis generation to hypothesis testing could be associated with movement from an open area through a narrow channel or restriction. We have also seen a number of applications in which avatars "vote with their feet," moving to different zones in a space to enact a decision and/or register agreement or disagreement with particular positions.[16]

Instantiation #1: The Memory Palace
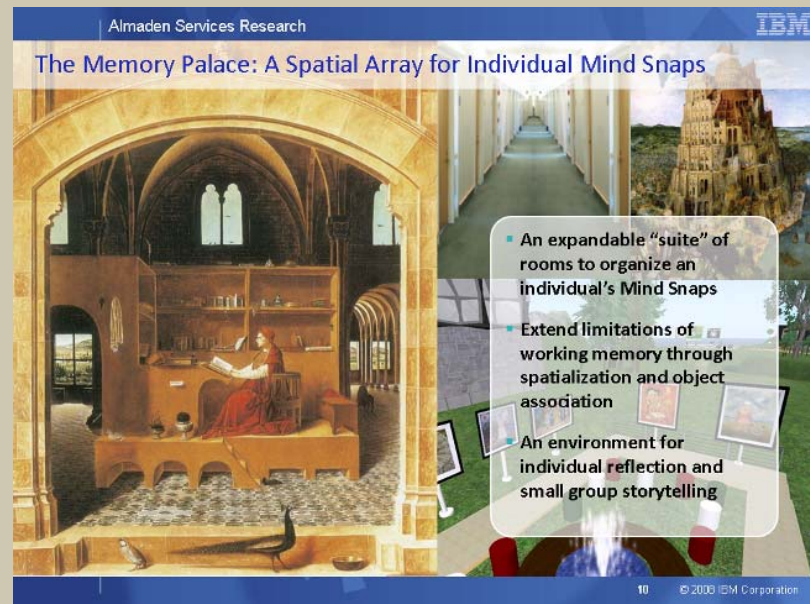
Two thousand years ago Marcus Tullius Cicero used to make two-hour speeches in the Roman Senate, without notes, by constructing in his mind a palace whose rooms and furnishings, as he imagined himself roaming through them, called up the ideas he wished to discuss: ideas were made memorable by locating them in space.

Lyndon, D. & Moore, C.W. (1994). *Chambers for a Memory Palace* (p.xi).

Analysts are challenged by overwhelming amounts of data and limitations of working memory. We are persuaded by the utility of the Mind Snap concept to allow analysts to preserve contextual relationships between different pieces of data and evidence, *and* to recall, recreate and share these with other analysts. As one accumulates more than a handful of Mind Snaps however, keeping track of them may become an issue in itself. A spatial array of rooms, chambers or paths could be used to distribute and structure an analysts "external memory" making items easier to recall and share. A range of configurations from compartmented to open, regular to varied, could be experimented with and empirically tested.

These examples are intended only to illustrate the richness of possibility, not proposals for specific configurations.

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[16] See for example Drew Harry's work a the Media Lab, "Unreal Meetings" http://www.technologyreview.com/web/19035/?a=f. One of our learning simulations also incorporated a spatial voting area, in which different categories of participant (IBM and Customers) could register their agreement or disagreement with statements displayed on placards.

Dynamic landscapes could be constructed to guide or scaffold progress on the basis of metrics and analytics running in the background, such that the content of conversations might alter attributes of structures like the colors of walls, atmospherics, landscaping and vegetation. We can imagine that avatars in a virtual environment might also be brought "physically" closer together when they are in agreement or are looking at the same sets of data. Conversely, these spatial dynamics could be reversed to highlight disagreement and juxtapose dissenting points of view in order that they might be more effectively resolved.

The ability to gather information about the locations, movements and activities of avatars within a virtual world—and the fact that all interactions are encoded, and therefore potentially recoverable and analyzable—open up a number of rich possibilities for visualization of aggregate patterns of presence, attention and interest. Location-based information could be recovered over time, to understand who had visited particular places and what the nature of their engagement was. The ability to survey a landscape from a particular point of view, and to radically alter our size, might allow us to survey patterns over large scales or inspect and experience minute details.

Avatar-mediated Interaction

The affordances virtual worlds offer in the area of avatar-mediated interaction open up three categories of opportunity we wish to discuss—avatars as self-representations, as agents, and as the essential online vehicles for the realization of certain forms of mass-connected collaboration, what Au (2008) termed an "impression society."

The most obvious consequence of the affordances for avatar customization is the avenues for self-representation that are created. Users evidently appreciate the ability to customize their appearance to communicate an identity to others, and that identity has a social function as well—it is easier to remember an avatar based on distinct features and characterizations. Statistics on the average numbers of avatars

Instantiation #2: Carmen Miranda

Analysts from different agencies, with differing backgrounds and expertise will need to work together to unravel tomorrow's threats, which Treverton & Gabbard (2008) likened more to mysteries than the puzzles of the past. Entering in to these situations, analysts will need ways of displaying for others to notice what they have been looking at, things that may have caught their attention but about which they are not yet sure.

Whereas the memory palace is a structure located in space, a place to which individuals come, "Carmen Miranda" is a way of carrying context into new interactions. Objects in the avatar's headdress could be live media, views to be expanded, or links to other places. These could be placed by the analyst, or suggested on the basis of the interactional context by background automation and data mining.

maintained by individual users on various platforms were noted above in Section 2. Why have multiple avatars? Just as a user might wish to tailor an avatar to project a particular identity, using a different avatar entirely allows the possibility of compartmentalizing identities—maintaining different identities for different contexts and purposes. In the multiplayer online game World of Warcraft (WoW) for example, users are able to try out different roles with characters that have different abilities, tools, and personal traits. But how might this relate to non-game environments applied to knowledge work? Fostering a level of remove between the user and any particular avatar may indeed convey certain advantages, such as a greater freedom to step in and out of character, and perhaps depersonalizing challenge or critique. (We elaborate one such possibility in the "Role-play" instantiation sidebar.)

The ability to couple more complex codes and scripts with more-or-less anthropomorphized online tokens of presence gives rise to various possibilities for semi-autonomous agents we might construct and authorize to act on our behalf. Of course, intelligent agents are the subject of much research and debate, so we would clarify where this substantial body of work impinges upon our concerns in this paper—that is, when agents are vehicles for interaction *between people,* all or part of which occurs within the context of a mimetic virtual world. In this case we would most likely be talking about agents facilitating asynchronous interaction—as otherwise people would most likely be interacting "directly" through their avatars. However we might also wish to augment our avatars with intelligent processes operating in the background, perhaps making discrete suggestions or otherwise injecting potentially useful content in an unobtrusive way, without requiring the user's focused attention. (The "Carmen Miranda" instantiation sidebar includes the latter possibility. See the "Mini-me" sidebar for an example of an agent to facilitate asynchronous interaction across temporal shifts in context.)

The last area of possibility we will discuss is in some ways less easily anticipated, but may be arguably the most consequential in the long run. That is the role avatar-mediated interaction plays in the creation of what Au (2008) dubbed, "an impression society," a social hierarchy in which members, "are most valued and respected to the degree they make cultural, economic, or social contributions with organic creative flair, distinction, and sustained effect." (Au 2008, p. 253) One consequence of the malleability of identity afforded by avatars may be a "leveling of the playing field," the creation of an interactional space in which status and prestige are less a

Instantiation #3: Mini-me
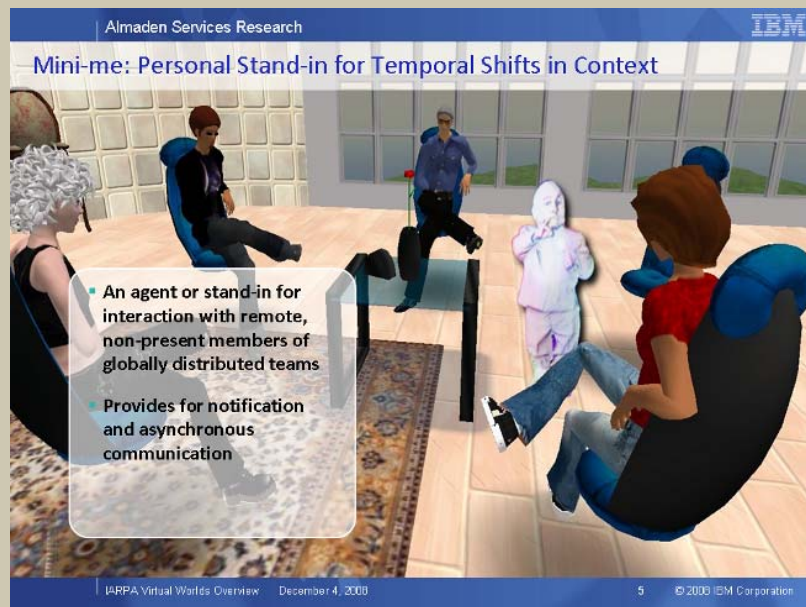
Many kinds of knowledge work are now becoming globally distributed, and this seems likely to be even more true of intelligence analysis in the future. With important synchronous interactions potentially occurring at all hours, members of distributed teams are often disadvantaged when meetings occur at times that are either inconvenient or that coincide with low-points in circadian rhythms. "Mini-me" would be an agent, conceivably invested with varying levels of intelligence or interactivity, that could be sent as a stand-in to record or take notes, also serving to remind other members of the group of that person's interests.

function of title, rank and position, and more directly the result of sustained, novel and useful contributions made to a community of inquiry or practice. While we cannot yet discern the potential relevance of this phenomenon to intelligence analysis, on its face this would appear to be a healthy prescription for knowledge work in general. Perhaps a positive consequence of the exposure the generation now entering the workforce has had to various forms of avatar-mediated online interaction, it may well characterize the expectations these young people carry into the workplaces of the future.[17]

Situated Enactment

An important area of opportunity for application of virtual world technology—perhaps the one we have made the most use of in our work at IBM, is in the area of virtual environments as sites for situated enactment of all kinds of work-related skills and activities. We believe this has many implications for enhanced learning and educational

Instantiation #4: Role Playing

Despite admonitions of the importance of ensuring that a range of hypotheses are considered, and that rigorous standards of evidence are used in evaluating them, analysts face many practical challenges applying known methodologies. Virtual worlds offer opportunities to enact creative hypothesis generation and robust evaluation by exploiting the malleability of identity (and anonymity) made possible by avatars.

Avatar-mediated interaction potentially levels the playing field and makes it easier for analysts to switch in and out of roles (and for others to know when they are doing so). Playing a particular role may become a skill in itself, and observation provides opportunities for learning and sharing of best practices.

experiences, as well as the potential of creating new spaces for work and collaboration.

Simulations for Education and Training

Some of the first areas in which the utility of virtual worlds have been compellingly demonstrated are in simulations for education and training. At IBM, whether it involves swapping out a blade server or understanding overall patterns of energy consumption in a data center, we have found that both service technicians and customers can benefit from seeing the relevant operations depicted in animated 3D as opposed to merely reading text descriptions.

Simulations have been recognized for some time as powerful educational tools. We noted in the A-SpaceX materials that current performers in 2008 were already developing virtual world technologies to provide accurate geospatial reconstructions of specific places in which scenarios can be proactively

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[17] This point is reinforced by Reeves et al. (2008) in their analysis of the implications of online gaming for the future of business leadership

played out, or forensically reconstructed from different points of view. And simulations are not necessarily confined only to physical properties and terrains. Effective operations around the world also involve understanding local cultures and norms. We also noted amongst 2008 A-SpaceX performers, a virtual-world-based interactive learning simulation for cross-cultural communication along these lines.

As mentioned above, our group has constructed several learning simulations for coaching in contract negotiations, for team project management in IT implementations, and for sales training in IBM's flagship mainframe business. These simulations all made use of the idea that learning can be more effective when it takes place in an authentic social context and is situated within environments that resemble (or indeed, are identical to) those in which the actual work is performed. As the work of intelligence analysis is increasingly played out in groups, the enhanced opportunities virtual worlds afford for observation and legitimate peripheral participation (Lave & Wenger, 1991) may substantially advance cross-agency training and community-wide sharing of methodologies and best practices.

Intelligent Objects & Environments for "Real" Work

As might have been clear from the above, we are often engaged in blurring the boundaries between training (certainly conventional training in classroom environments) and real work. Beyond learning experiences, we believe virtual worlds have great potential to augment the way actual knowledge work is carried out. Here, interactive objects will move beyond the execution of simple animations and scripts. By invoking more sophisticated code, intelligent objects will be able to collect a variety of information about the interaction that is taking place around them and modulate their behavior appropriately according to context. Real-time analytics & metrics running in the background might allow objects and environments to become more active participants in interaction, providing accountability and helping to reinforce value-creating patterns—perhaps making suggestions, raising objections or providing feedback. Imagine a room that would begin to express boredom if conversational participants weren't being interesting enough!

Instantiation #5: A Data Market

As collectors produce overwhelming volumes of data, analysts' attention becomes an increasingly scarce resource. Market mechanisms may be useful as ways of making complex allocation decisions, focusing collectors on the issues that matter to analysts and helping analysts to prioritize, for example by bidding for the attention of others.

Virtual worlds offer the possibility of rapid, synoptic visual awareness of complex fields of information (and where others are positioning themselves) with relatively low cognitive load. Here, an analyst might explore a high-dimensional data space and extract information to populate a less-dense space in which she could interact with other analysts.

We can also foresee that intelligent virtual environments might have the ability to *make* persistent objects out of things that are normally fleeting and evanescent in everyday face-to-face interaction—such as words. For example, imagine that real-time text analytics could be applied to chat and recognized voice to construct "tag clouds" above the heads of avatars, or (particularly in the case of topics that garner substantial engagement across participants) in the space *between* them. Participants in such augmented conversations would have access to a persistent visual trace of what they were talking about, where they had found commonalities and disagreements, as well as tangents taken and topics that might otherwise have been forgotten.

Synthetic Currencies & Market Mechanisms

Once you have a virtual economy going, synthetic (artificial? virtual?) currency can't be far behind. Currency is, of course a unit of exchange and in the virtual world we see both virtual and real currency as being relevant. Second Life is famous for its Lindens, which are pegged to the US dollar. You can buy Lindens with your credit card, where the value related to the US Dollar can fluctuate. Alternatively you can commission a particular virtual world or a build to your specifications which you pay for with real currency.

We see synthetic currencies as a rich source of opportunity. They make it easy to buy and sell all that stuff people make in virtual worlds. Clothing etc. for customizing your avatar, outfits to play certain roles, a representation of Predator drones or a section of Baghdad. And markets don't necessarily have to be limited to goods—here we recognize significant work that has gone into the use of markets to make predictions, and the use of currencies to value scarce resources that are not necessarily material.

At the heart of an economy and its attendant currencies, after all, is the ability to place a value on a scarce resource. The company Seriosity has a currency called Serios, which are measures of attention—what individuals find important—which could provide

Instantiation #6: CustomerLand

To improve the collective efficacy of the intelligence community, thoughtful commentators (cf. Treverton & Gabbard 2008, Johnston 2005) advocate allowing analysts to organize themselves around issues and problems, rather than solely by agency affiliation and collection sources. Whereas the preceding instantiation dealt with the collector/analyst interface, "CustomerLand" would apply similar logic to the interface between analysts and customers—the recipients of intelligence products.

This visualization comes from "Bluegrass," a virtual environment for software developers within IBM. Trees on the landscape represent projects and mobile wagons indicate programmers at work. Length of grass around each reflects code issues of varying severity. If the visual appearance doesn't suit your taste, that points up another advantage of virtual worlds: done properly, it is comparatively easy to change the skins on underlying code and data structures.

Instantiation #7: GroupSnap

GroupSnap: Intelligent Presentation Objects & Environment

- Automated logging of media and participants' presence & actions
- Auto-detection of "resonance" and/or systematic differences of opinion amongst participants

Virtual worlds offer many affordances to promote synchronous interaction for idea generation, problem solving and decision making. Instrumenting these environments will make possible tracking who is present, what data are presented and the contributions of various participants. Data-mining and analytics could be used to provide feedback to participants regarding their interaction, including the positions taken and how others may have viewed the same information.

In addition to providing an audit trail, such a system could help identify when key "punctuation points" in process may have occurred, either to better understand effective insight or to ensure that mistakes of the past are not repeated.

another measure of value. Data of course has value to analysts, but only so much data and only the data that provides value to the analysis. In that sense *productive* data has more value. (We suggest two ways of making visible what data people value, in the "Data Market" and "CustomerLand" instantiation sidebars.)

Instrumentation & Analytics

The work of analysts, and many kinds of knowledge worker depends upon making connections between pieces of information across disparate data sources, locating resources, obtaining commitments and applying expertise to transform information inputs into knowledge outputs. Given the pervasive digitalization of information in virtual worlds, many opportunities exist to log the constituent objects and acts of these activities so that they can be recovered, reconstructed, and compared across contexts. The need will be for tools that allow analysts to get on with their work, capturing information and logging connections as they are made, in a transparent manner—not requiring "extra" work to go back and document. Or, in cases where such documentation *is* routinely necessary, the tools can contribute substantial value by offering this documentation as a natural by-product of use. Our experience suggests these tools should be as simple and lightweight as possible, tolerant of legacy systems, practices and mixed media formats. It can be argued that this is true in any case, but it will be particularly important when utilizing virtual world technologies to be sure the barriers to analysts bringing in the information they need to work with are as low as possible. What is true for analysts' individual work practices is also true for their work together. This is where the digitalization of interaction in virtual worlds may yield particular dividends in realizing the aspiration expressed by Treverton & Gabbard (2008) at the top of this section. The connection-making activity *between* analysts can also be captured and fed back to analysts to guide their interaction (illustrated in the "GroupSnap" instantiation sidebar), as well as providing the basis for correlating process with outcome, essential for long-term process improvement.

4. CONSIDERATIONS FOR DESIGNING WITH VIRTUAL WORLD TECHNOLOGIES

In this section we bring together insights from the use of the framework discussed in this paper and experiences we have had in developing in and for the 3D virtual world space over the last two years (2006-2008).

As is evident from the above, we believe that "mimetic" virtual worlds—those that employ an explicit geographic or geospatial metaphor and avatar-mediated interaction—offer significant advantages for certain kinds of tasks, by virtue of their leverage of basic human cognitive and perceptual architectures. We have argued too that effective use of this metaphorical leverage can potentially transform our everyday experience of moving through space, interacting with people and all manner of objects, into a tremendous resource to reduce cognitive load and make multi-user computer-mediated interaction more fluid and intuitive.

Virtual worlds excel at bringing people together to do real work in an environment that can both mimic and augment the real world. This does not mean that virtual worlds are ideal for everything—indeed we will discuss a number of challenges and issues below. We have seen that substantial time and effort can be devoted to things that, in the end, do not offer clear advantages over more conventional means and legacy systems. It is all too easy to try to make each new technology into a new and ever so much better kitchen sink.[18]

Lessons Learned

Be principled in what you choose to put "in world" and why

We developed the framework described in the preceding sections precisely because these virtual worlds pretty much allow you to create environments and experiences that do mimic the real world in many ways. There are even proposals to create a "Paraverse" a mirror world that exists in parallel to the real world and eventually is as rich a virtual world as the real world is. In this view, the world is a metaphor. Whether that is a good idea or not, whether that is feasible or not, is not the subject of our explorations here. Rather, we've focused on the knowledge work of intelligence analysts. Use a framework; be principled whether you use this framework or some other. Forethought, deliberation and careful determinations are in order. Based on the framework we outlined earlier, two main principles stand out.

- **First**, when considering the use of a virtual world platform toward a particular end, try to ensure that what the <u>metaphorical clarity</u> – deciding which affordances to use and why – buys in terms of cognitive scaffolding, is likely to outweigh <u>limitations and drawbacks</u> (e.g. lower symbolic density, reduction of high-dimensional spaces, work required to import information, etc.). We believe this tradeoff is most likely to occur:
    - in support of collective and interactional aspects of work when maintaining shared focus, orientation, clarity of reference and developing shared understanding

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[18] One of the most dramatic requests we had illustrates this. An internal client, in wanting to evaluate this new virtual world technology asked us to "implement" an e-learning course in a virtual world platform. Now most of our (IBM's) e-learning courses are sets of PowerPoint slides. They are text-based, designed for individuals to go through anywhere, anytime by themselves. Against our better judgment, we ended up creating a "room" in which people guided their avatars through stations on their own and viewed PowerPoint presentations. The users, on the first pilot simply remarked that they couldn't understand what the "value add" was. We couldn't either.

- in tasks that essentially involve understanding or working with inherently spatial relationships and constraints
- when there is a clear schematic mapping (e.g. of directionality, centrality) onto the intent or successful realization of the activity.

- **Second**, when confident of the above, resist the temptation to map or reproduce *every* aspect of the real world analog in the virtual world. Emphasize those aspects that accomplish the relevant cognitive work. Exploit the ability to violate constraints that would otherwise pertain to achieve greater effect.

Make use of a rigorous design practice

Just as it is important to be principled about what you put in the world and why, it is important to have a design methodology in mind. There are a number of options when designing technological support for any user group: user-centered design, interaction design, activity-centered design, experience design and the like, each approach with its own conferences, journals and methods. This isn't the place to compare all the approaches, but we do encourage people to go through some sort of rigorous design process. We have our own favorites, which we make use of here, a practice-centered approach.[19]

Designing and developing technologies that "fit the practice" of the user population (whether that practice is current or strategic) has several consequences. It should go without saying that if intelligence analysts are to use virtual world applications, it is crucial to understand not only what type of work intelligence analysts do but how they do it, i.e., their practice. (It is stunning how little technology design actually proceeds under that assumption.) So for instance, if a significant number of analysts actually spread printouts on the all over the floor, patterns that might be something to explore more deeply. What affordances does the paper on the floor provide and how might we usefully design a solution that does the same work that those affordances do? Such single examples can seem trivial, but they all add up to what makes the work easier and more effective. An added bonus? There is reason to think that cultural issues are actually better resolved in terms of practice (e.g., Bauman, 1999). Of course it is possible that once a specific practice such as this is made visible, its users or other stakeholders may notice that there is a strategic misfit, a reason not to want to create aspects of the virtual world environment that encourage that practice. To the extent that intelligence analysis has cultural transformation in mind, then practice-centered design can serve as a useful approach.

But at least the issue can be addressed. In short, creating something with the user population in mind allows for a better chance of adoption of the technology because it is more likely to be useful if the user needs are met. The overhead of using a new technology ("the learning curve") can easily deter users from fully adopting new technologies into a work environment.

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[19] By 'practice' we mean the ways in which people actually get their work done. People can follow the same process, but end up with very different results. Practice is not something that people can tell you—indeed work practice analysis was developed to provide the fine-grained understanding of what people actually do, not what they say they do. In general it covers the interaction of people and their technologies and other artifacts of work. Classic examples, many of them dating from work at Xerox PARC in the 80's and 90's include studies demonstrating the difference between what people say they are doing and what they actually do. Finding the patterns of interaction in what people actually do makes adoption and adaptation go more smoothly. It does add complexity if it is deemed important the new practice be developed. For example, addressing the challenges of wanting more collaboration while working remotely.

Understanding the user's practice needs to be part of an overall design methodology for designing and developing virtual world applications. We've gone through this exercise in our own Rehearsal Services work at IBM. We now take our clients through a process called "Designing the Rehearsal Service Experience." The phases of the Designing the Rehearsal Service Experience include situation assessment (observation of the practice, information discussions, interviews), concept (sketching storylines, maps of the environment, landscape design and rapid prototyping), design (storyboarding and rapid prototyping), development, delivery, and assessment. A crucial part of this methodology is to complete a thorough situation assessment where is we get a broader feel into the actions, thoughts, concerns and practices of users so that what we create is appropriate to and resonant with the broader context of the user's job. The situation assessment is more than just collecting user requirements; it is aimed at understanding what will help the user be productive and successful in their practice.

Look for solutions to technical interoperability challenges

There are (at least) four types of interoperability that need to be tracked when using virtual world technologies. If you follow the communities that are engaged in this kind of platform development, you see changes weekly. Thus, we frame here only the broad outlines of the considerations. Any specific illustration we provide will be outdated nearly as soon as it is on the page. For example, in order to increase adoptability, nearly every player among the platforms now has a viable way to incorporate PowerPoint. (In the recent past, developers "one-offed" their solutions). Linden lab has partnered with Rivers Run Red to create "office-like capabilities. Qwaq has had this down from the beginning. Forterra now has a robust solution.

1. Interoperability among virtual world platforms

As it stands now, it is difficult to move a "build" or parts of one from one virtual world platform to another. It is equally difficult to move avatars across platforms, though there are some one-off "translations" such as the one IBM helped develop interoperability across Second Life Grid and OpenSim (an open source version of Second Life). This will remain complex and challenging for some time to come, while standards emerge, new platforms are developed and the market shakes out overall. This means that whatever you develop on one platform will disappear if the platform disappears. It means that if your organization switches platforms, you would have to redo the build.

We can expect this challenge to be addressed in the short term me as more and more standards emerge. It will be important for developers to follow the debates. Many of these will be the same debates that rage in computer science in general. Will an intermediate level of abstraction be helpful? How much can API's handle? Will one platform (like Microsoft Office, emerge as a standard for awhile)? It is hard to say, but one thing is that translating from one platform to another directly is probably not a very tenable solution.

2. Interoperability between existing applications/programs and virtual worlds

No sooner do you start to use virtual world platforms to design and build environments in which to do real work than you want to have access to other applications. For instance, when organizations start to meet or conduct learning experiences in virtual worlds, they can't seem get along without their PowerPoint.

Virtual world platforms currently have widely differing technology specs. This is to be expected in the early day and will no doubt settle down. For instance, floating point arithmetic is handled differently in Second Life than it is in its open source counterpart, OpenSim.

Here the platforms differ along various dimensions with respect to their native affordances. We see constructed affordances "sedimenting" into native affordances on a regular basis. For example, VOIP was, in Second Life, a constructed affordance. It didn't come with the platform. Now it does. Qwaq, natively does text much better than, say Active Worlds. Sometimes the solution is not to bring it in, but provide a direct link to, say, a web site. What effect this kind of "break" has on the effectiveness of an experience in a virtual world is not yet known. It may be that "blended reality" will make these kinds of things seamless.

3. Information interoperability and content translation

In addition to this technical interoperability, there is the question of how directly to render it. Do you just make it look approximately like what you have in the native application? Or do you take advantages of the native virtual world affordances to develop a more compelling kind of experience. So, for example, do you "post" reports as visible text in the virtual world or do you provide a way for people to represent the argument in their report as a "dashboard" of representations of data? Resolving this sort of conundrum will take some design experimentation to address.

4. Interoperability across analysts' work

Suppose that different analysts are working on different parts of the same analysis. They could work in the same virtual world environment asynchronously, much the way people write a paper together. In a virtual world, you can "rez up" or render copies of the same environment, restrict access and people to work on them independently and asynchronously. What happens when it is time to synthesize the results? There are many tantalizing possibilities here and for the foreseeable future it will be important to try out lots of them to see what works best.

It almost goes without saying that there are numerous government technical standards, within and across applications for content packaging and delivery (e.g. SCORM, SD1000, CORDRA), with which compliance needs to be considered.

General Guidance for Addressing the Heilmeier Questions

We hardly need to say this to IARPA who (along with other government R&D organizations) uses the Heilmeier Questions to instill rigor in the development of their projects and programs. We thought it would be important to provide guidance for those addressing those questions when programs or projects are being proposed that explore the use virtual world technologies. While we have had in mind the proposed A-SpaceX programs, in particular the concept of Mind Snaps, this guidance may be of help in thinking through any program that proposes to use the current crop of 3D virtual world technologies and the rapidly emerging design methods and techniques associated with them.

There are a number of ways that virtual world technologies could be of interest to the Intelligence Community. One important one is how groups or individuals might use virtual worlds to promote or even consummate activities that put national security in jeopardy. IARPA is, we understand, presently considering a program to investigate just these possibilities. The one we have been focusing on in this paper is how 3D virtual world technologies might be used to advantage in intelligence analysis itself.

In going through the Heilmeier exercise below, we concentrate on the intersection between several challenges intelligence analysis faces[20] and the affordances that 3D virtual world technologies provide. This is the thrust of the guidance we provide below.

1. What are you trying to do?

Assist the intelligence analyst community in their quest to "outthink the adversary" by providing new ways to integrate and synthesize information, build and test hypotheses by amplifying both individual and social cognition.

2. How does this get done at present? Who does it? What are the limitations of the present approaches?

Not only are analysts inundated with data, they do not have work spaces that allow them to aggregate visually, many different kinds of data (text, geo-spatial visualizations, maps, and so on) where they can also easily share their insights with each other and with their customers. Of course they do aggregate many different kinds of data and they do share their compilations and stories with their fellow analysts and their customers. For instance, analysts print things out, and they spread the papers on their floors in their offices. They tile their computer screens to keep like things together. These compilations, which provide the basis for insight and later, hypotheses, are fleeting, however. They aren't recorded, or mined as they could be if they were compiled in the "same place, digitally." An individual may easily forget what it was that generated a particular insight if they noticed. It's difficult to invite enough people over to your office to look at your assemblage of data if it is spread out on the floor. And you can't easily keep multiple stories going on your floor.

Moreover a group of people making sense of an argument or hypothesis may not even notice that they have resonated around a particular idea or when they, as a group, have had an insight. Patterns of insight can be missed altogether. Outliers ignored.

3. What is new about your approach? Why do you think you can be successful at this time?

3D representations in the form of simulations and virtual reality have been around for a long time, so that is not what is new. What is new here is that the recent appearance of 3D virtual world platforms (the Second Life Grid, Forterra's Olive, Qwaq Forums and Sun's Wonderland, for example) are easier to use and less expensive than earlier alternatives. You can rapidly prototype and test ideas. The next generation of analysts now being hired are digital natives. Not only do they know how to use a wide variety of tools, they are used to sharing information (maybe a little too interested in sharing information!).

In the second place, the digitalization of interaction makes it possible to record and track their interactions with data and, significantly, with other people. This capability raises a lot of questions around privacy and security, of course, but with appropriate protections, you can capture a lot of data that can be analyzed for patterns of interaction that might otherwise go undetected.

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[20] According to the list provided in the A-SpaceX program documents, and in, for instance, Treverton & Gabbard (2008) and Johnston (2005)

4. If you succeed, what difference will it make?

The kind of work space that can be easily prototyped and tested may, if designed for and by the Net generation, to want to work in the profession of intelligence analysis. It makes it easier to work together when not co-located. Certainly, there are affordances here not provided by teleconference, videoconference or many of the other collaboration tools we are familiar with. As we noted, simply operating your avatar with others increases the sense of presence and we hypothesize, accountability.

5. How long will it take and how much will it cost? What are your midterm and final exams?

It will take longer than you want and cost more than you want at first surmise. Over time we will have enough experience to better estimate what it will take. We do want to point out in particular, rumors of "cheap and cheerful" rest on having a summer intern or two or three or four. These builds often do not have the kind of security or robustness that would be required for intelligence analysis. They range from proofs of concept through pilot, and not much more. That said, we are talking in the millions, not billions of dollars. These platforms provide great support for rapid prototyping, one of their great attractions. Beware arguments about ROI. The replicability and adaptability of the environments that can be created means that

"Midterm and final exams" brings to mind the kind of metrics that will be needed to evaluate both the framework and instantiations that it generates. For instance, is breaking out the space, place and landscape from the objects and things justified? We argued that based on how humans process the two kinds of data, it was. The second is evaluation of an instantiation. Does what you built help an analyst communicate with a customer better than on the phone or through a report?

5. CONCLUSIONS

We provided a research-based schema called *A Framework for Designing with Virtual World Technologies*. We showed how, by using this framework, virtual world technologies can be used to radically transform how intelligence analysts encounter data, frame their stories, and review their analyses with both their customers and other analysts. We explore what analysts can accomplish by doing some of their work in environments that can be created in virtual world platforms.

The framework is foundational in a number of ways. By being theoretically based, it helps brings virtual worlds and cognition to design of these environments. This is essential because intelligence analysis is quintessential knowledge work. It is a cognitive activity, and behooves us to understand the affordances of virtual worlds in those terms. On a more practical level, as our experience has shown us over the past two years, developing virtual world applications benefits from diligence in the design process. Moving from offset printing to desktop-publishing wasn't so smooth at the beginning and there were some pretty ugly and unreadable documents floating around.

A framework helps too, to identify the particular literatures that bear upon each piece at the bottom, anchoring a cognitive-metaphorical understanding of how to deploy the pieces toward work-relevant design objectives. It helps to understand and portray the way Arthurian "encounter" and "recombination" (that we referenced at the beginning of the paper), are manifest as you move up from the native through the constructed affordances and into the opportunities (the active design space). It thus makes the inherent complexity in these combinations of technologies more manageable.

As the reader will have noticed, the space of affordances we uncovered turned out to be quite large, so that we began to understand just how much latitude there was, and that too led us to stress the design process with opportunities and instantiations. It also became clear that there are clear tradeoffs to be made when constructing affordances. People seem to immediately think that the more real something is the better it is. But it is not clear that this is true. There are times when you want to violate constraints that the real world has. For instance, does it make sense to use the size of something to indicate how many people have found a particular data set compelling? How about having the room grow brighter when people's avatars are interacting more? Precisely because you can violate constraints that are not easy to do in the real world, it is important to have principled ways of choosing among the myriad opportunities that virtual worlds present.

This framework was also developed in the virtual world affordances will appear in different combinations. Things that were part of the constructed affordances turn up as native affordances. For example, Forterra recently integrated Lotus Notes Sametime (an instant messaging system) so that if you ping someone you and that person or other persons can pop up your avatars in a space together. There are lots of choices at that point – what kind of space should it be? Why? Google's lively had avatars, but no real ability to build or construct objects. Was it therefore too sparse to work?

We remain enthusiastic about the potential of these technologies to make the fleeting nature of the work intelligence analysts do more durable, more open to colleagues and customers when that is desirable. At last, the practice of intelligence analysis may become less mystifying, making training more effective and the process inherent in the tradecraft itself more visible and open to improvement.

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AUTHORS & ACKNOWLEDGEMENTS

Wendy Ark, Ph. D. has worked for IBM Research since 1997. She started in the User System Ergonomics Research Group focusing on Human-Computer Interface research. She was also a member of the Developmental Cognitive Neuroscience Laboratory at UCSD where she studied the development of visuospatial cognition in humans. Most recently, she is a Research Scientist in the Almaden Services Research group focusing on a program called Rehearsal Services, under the direction of Susan Stucky. She has been designing, developing, and analyzing rehearsal experiences for business professionals in virtual worlds for the past two years. She received her B.S. in Computer Science with a concentration in mathematics from the University of Delaware and her M.S. and Ph.D. in Cognitive Science from the University of California, San Diego.

Ben Shaw, Ph.D. is a post-doctoral fellow in Service Science and Service Design at IBM Research. His prior research has focused on collaborative design practice and the use of shared visual representations. He developed network-based methods and analytics for design interaction based on fieldwork with a radically-accelerated concurrent design practice at Jet Propulsion Laboratory. He has additional experience in knowledge management and socio-technical knowledge systems consulting in organizations. He has extensive prior experience in engineering and product design in various consumer electronic, bio-medical and workplace environment/interiors areas. He is also a member of IBM Almaden Services Research's Rehearsal Services group.

Susan U. Stucky, Ph. D. (Corresponding author: sustucky@us.ibm.com) has experience in developing research programs and research institutes (the Center for Language and Information at Stanford University in the 1980's, the Xerox founded Institute for Research on Learning in the 1990's, and a research-based consultancy, The Strategic Practices Group, Inc. in the early 2000's). Presently she is leading the development of the Rehearsal Services Program at IBM Research in using virtual world technologies to provide experience-based learning. In addition, the Service Design Group that she leads is developing service analytics based on social patterns of interaction and service system design methods. Her Ph. D. is in Linguistics and she has post-doctoral training in Cognitive Science and AI.

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http://vworld.fas.org/wiki/Category:Virtual_Worlds

KZero.co.uk. Virtual World market demographics and total registered accounts.
http://www.kzero.co.uk/blog/?page_id=2092
http://www.kzero.co.uk/blog/wp-content/uploads/2008/09/universe-v6-master.jpg

Virtual World News Sites

Virtual World News http://www.virtualworldsnews.com

IBM Virtual Worlds Academic Community

IBM or academic Email address required to join
https://www.ibm.com/communities/service/html/communityview?communityUuid=13abd675-b20e-462f-8d16-156b28fc2d1f

Conferences

Specifically about Virtual Worlds

3D Training, Learning and Collaboration
http://www.3dtlc.com/

Culture of Virtual Worlds
http://www.anthro.uci.edu/vws/

Engage! Expo (formerly the Virtual Worlds Conference)
http://www.virtualworlds2007.com/

Federal Virtual Worlds Expo: Implementing the Future
http://www.ndu.edu/irmc/fedconsortium_agenda.html

Mardi Gras Conference (Louisiana State University Center for Computation and Technology)
http://www.mardigrasconference.org/

NASA Virtual Worlds and Immersive Environments Workshop
http://amesevents.arc.nasa.gov/virtual-worlds/

Second Life Community Convention
http://www.slconvention.org/

Virtual World Conference & Expo
http://virtualworld-conference-expo.net/english/index.html

The Virtual Worlds in Education Conference
http://hawk.aos.ecu.edu/secondlife/Pages/SL-Conference2.html

Conferences with Tracks on Virtual Worlds

ACM Conference on Computer Supported Cooperative Work (CSCW)
   http://www.cscw2010.org/

Computer-Human Interaction (CHI)
   http://www.chi2009.org/

Conference on Communities and Technologies
   http://cct2009.ist.psu.edu/

DigitalWorld
   http://www.iaria.org/conferences2009/DigitalWorld09.html

European Computer Supported Cooperative Work (ECSCW)
   http://www.ecscw09.org/

Hawaii International Conference on System Sciences (HICSS)
   http://www.hicss.hawaii.edu/hicss_42/apahome42.htm

HCI International
   http://www.hcii2009.org/

IET International Conference on Intelligent Environments
   http://conferences.theiet.org/ie08/index.htm

International and Interdisciplinary Conference of the Association of Internet Researchers (AoIR)
   http://ir10.aoir.org/?page_id=8

International Conference on Intelligent User Interfaces (IUI)
   http://www.iuiconf.org/cfp.html

User Interface Software and Technology (UIST)
   http://www.uist.org

Journals

Computer Animation and Virtual Worlds
   http://www.wiley.com/WileyCDA/WileyTitle/productCd-CAV.html

Cyberpsychology: Journal of Psychosocial Research on Cyberspace
   http://www.cyberpsychology.eu/index.php

Journal of Gaming & Virtual Worlds
   http://www.intellectbooks.co.uk/journals.php?issn=1757191X

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